

## TEST EFFECTIVENESS TREND OBSERVATION

### EMC Testing Significance

#### REFERENCES:

1. Bloomquist, C., Graham, W., Henmi, P., "Analysis of On-orbit Anomalies of Meteorological Satellites", PRC R-1869, May 8, 1979.
2. Bloomquist, C., Graham, W. "Analysis of Spacecraft On-orbit Anomalies and Lifetimes", PRC R-3579, Feb. 10, 1983.
3. Bloomquist, C., Graham, W. "Analysis of In-Flight Spacecraft Performance and Anomaly Data", PRC R-4416, Oct., 1984.

#### CONCLUSION:

EMC environmental testing has increased in significance as the electronic functional elements have decreased in size and mass. Thermal and thermal/vacuum testing is the dominate environmental test for uncovering problems. Dynamic testing places second, as noted in TETA TO-0003 and as consistent with general aerospace experience, but EMC has become much more significant in the last decade.

#### DISCUSSION:

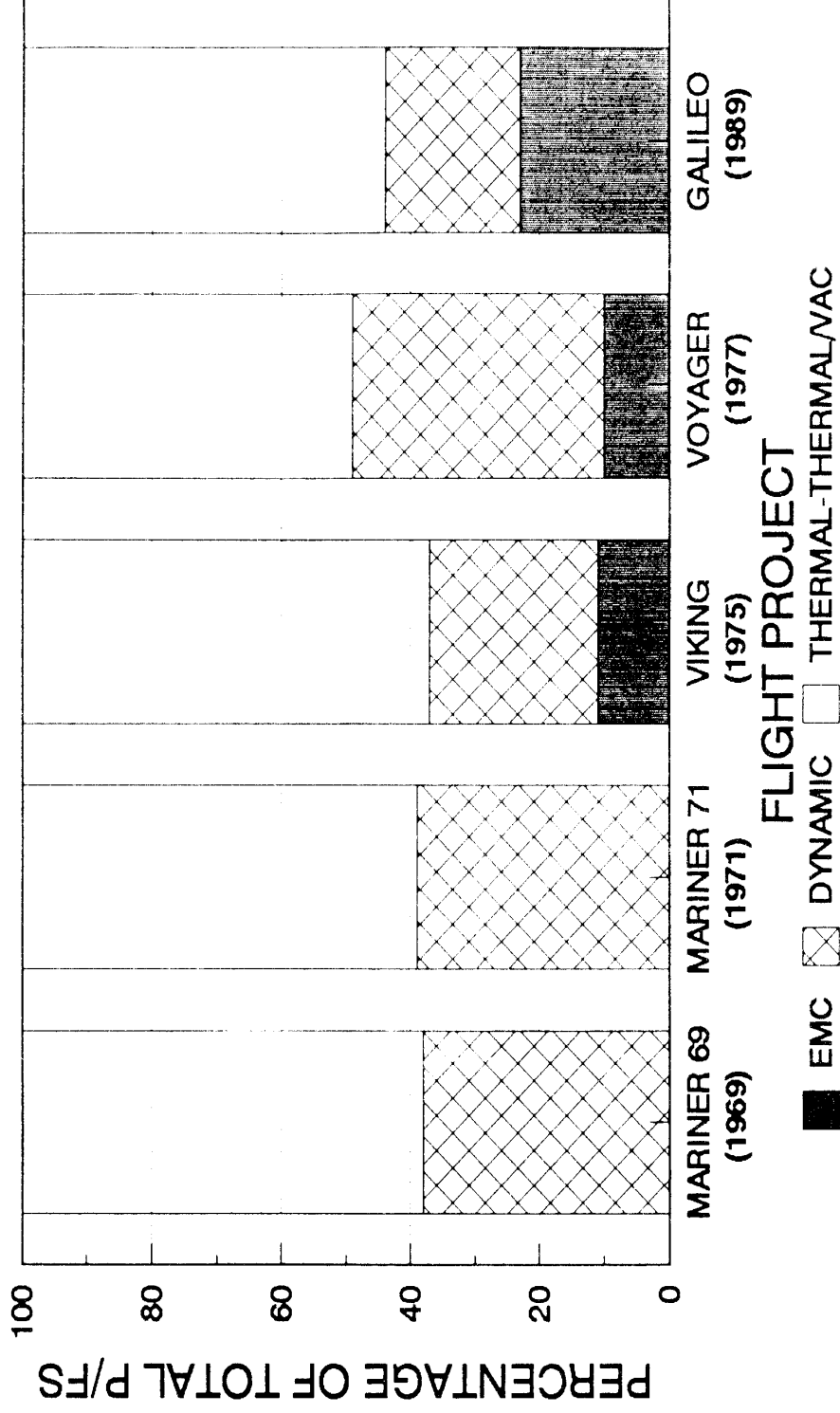
The attached figure provides a composite comparison, across five flight programs ranging from Mariner 69 to Galileo, of the percentage of problems and failures (P/Fs) written against each of three test environments for assembly-level tests. The three environmental categories considered were:

1. Dynamics, including sine and random vibration, pyro shock, and acoustic;
2. Thermal and thermal/vacuum; and
3. EMC.

As the figure indicates, EMC environmental testing has become much more significant. For the Mariner spacecraft's late 60's technology, the EMC testing contribution was insignificant-- essentially zero. For the early to mid 70's technology of the Viking and Voyager spacecraft, the EMC testing uncovered 10% of the total problems found by environmental testing. For the Galileo spacecraft's early 80's technology, EMC testing uncovered over 22% of such problems.

# ASSEMBLY-LEVEL P/F S VS TEST ENVIRONMENT

## BY PROJECT



This suggests that the significance of EMC testing is inversely proportional to the size and mass of the electronic elements. As electronic functional elements have advanced to the micron range, they have also advanced in sensitivity to the EMC environment, and EMC testing is playing an increasingly important roll in the environmental test program.

Studies of in-flight anomalies by the Planning Research Corporation (PRC) indicate that EMC problems occurred on 50% of the satellites and spacecraft included in their studies. All three studies published since 1979 (Refs. 1-3) have ranked EMC problems in the top three problem areas. Although many of the EMC problems did not significantly affect spacecraft performance, some were serious enough to cause loss of science data or redundant hardware.

A comparison of the distribution of EMC problems by hardware for the Viking Orbiter, Voyager, and Galileo environmental tests with the distribution of the PRC flight observations reflects an interesting similarity. Twenty-eight percent of the in-flight EMC problems occurred on science instruments and thirty-three percent of the JPL ground-test problems occurred on science instruments; the rest occurred on spacecraft hardware (non-instruments).